CLAIMS

1. A light irradiating apparatus comprising:

a laser source to emit a light beam;

a stage to support a flat to-be-irradiated object;

an irradiating means including a deflecting means for deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and which guides the light beam emitted from the laser source and irradiates the light beam to the main surface of the to-be-irradiated object while scanning the light beam in a first direction along the main surface of the to-be-irradiated object;

a light beam emission controlling means for controlling the light beam emission from the laser source correspondingly to the angle of deflection of the light beam;

a first controlling means for irradiating the light beam, of which the emission has been controlled by the light beam emission controlling means, to the main surface of the to-be-irradiated object while scanning the light beam in the first direction, and moving the stage in relation to the irradiating means in a second direction perpendicular to the first direction along the main surface of the to-be-irradiated object; and

a second controlling means for controlling the stage, once moved by the first controlling means, to move in relation to the irradiating means in the first direction,

the light beam irradiation controlled by the first controlling means being made to

the same to-be-irradiated surface of the to-be-irradiated object in each of a plurality of different positions along the first direction, reached under the control of the second controlling means, and almost all the to-be-irradiated surfaces of the to-be-irradiated object undergoing the light beam irradiation controlled by the first controlling means in each of the different positions.

2. The apparatus according to claim 1, wherein the laser source generates light beam pulses.

3. The apparatus according to claim 1, wherein the light beam emission controlling means operates alternately in a first control mode in which it controls the laser source to start generation of light beam pulses when the angle of deflection becomes θ_a after taking a first extreme value and to stop generation of light beam pulses when the angle of deflection becomes θ_b after that, and in a second control mode in which it controls the laser source to start generation of light beam pulses when the angle of deflection becomes θ_c after taking a first extreme value and to stop generation of light beam pulses when the angle of deflection becomes θ_d after that.

4. The apparatus according to claim 3, wherein the angles of deflection θ_a and θ_d are equal to each other and the angles of deflection θ_b and θ_c.

5. The apparatus according to claim 3, wherein the angle of deflection θ_a is a value closer to the first extreme value than the angle of deflection θ_d and the angle of deflection θ_c is a value closer to the second extreme value than the angle of deflection θ_b.

6. The apparatus according to claim 5, wherein the deflecting means deflects the light beam at a frequency f_{galvo} as given by the following equation (1) and the moving stage moves at a velocity V_{stage} as given by the following equation (2) in the first direction:

$$f_{galvo} = (F_{rep} \cdot W_x)/(2D) \quad \ldots\ldots \quad (1)$$

$$V_{stage} = (F_{rep} \cdot W_x \cdot W_y)/(2D) \quad \ldots\ldots \quad (2)$$

where F_{rep} is a repetition rate at which the laser source generates light beam pulses, W_x is a first-directional length of a spot defined on the to-be-irradiated object, W_y is a second-directional length of the spot defined on the to-be-irradiated object, and D is an amplitude of a trajectory of the center of the light beam spot defined on the to-be-irradiated object when the light beam emitted from the laser source is ideally deflected.

7. The apparatus according to claim 5, wherein:

the light beam emission controlling means makes a first-directional length of a first irradiation area defined by the irradiated light beam whose angle of deflection ranges from θ_a to θ_b coincide with a first-directional length of a second region of irradiation defined by the irradiated light beam whose angle of deflection ranges from θ_c to θ_d and sets the length of a first-directional displacement between the first and second irradiation areas to $W_x/3$; and

the deflecting means deflects the light beam at a frequency f_{galvo} as given by the following equation (3) and the moving stage moves at a velocity V_{stage} as given by the

following equation (4) in the first direction:

$$f_{galvo} = (F_{rep} \cdot W_x)/(3D) \quad \ldots\ldots \quad (3)$$

$$V_{stage} = (F_{rep} \cdot W_x \cdot W_y)/(3D) \quad \ldots\ldots \quad (4)$$

8. The apparatus according to claim 3, wherein the angle of deflection θ_d is a value closer to the first extreme value than the angle of deflection θ_a and the angle of deflection θ_b is a value closer to the second extreme value than the angle of deflection θ_c.

9. The apparatus according to claim 8, wherein the deflecting means deflects the light beam at a frequency f_{galvo} as given by the following equation (5) and the moving stage moves at a velocity V_{stage} as given by the following equation (6) in the first direction:

$$f_{galvo} = (F_{rep} \cdot W_x)/(2D) \quad \ldots\ldots \quad (5)$$

$$V_{stage} = (F_{rep} \cdot W_x \cdot W_y)/(2D) \quad \ldots\ldots \quad (6)$$

10. The apparatus according to claim 8, wherein:

the light beam emission controlling means makes a first-directional length of a first irradiation area defined by the irradiated light beam whose angle of deflection ranges from θ_a to θ_b coincide with a first-directional length of a second region of irradiation defined by the irradiated light beam whose angle of deflection ranges from θ_c to θ_d and sets the length of a first-directional displacement between the first and second irradiation areas to $W_x/3$; and

the deflecting means deflects the light beam at a frequency f_{galvo} as given by the

following equation (7) and the moving stage moves at a velocity V_{stage} as given by the following equation (8) in the first direction:

$$f_{galvo} = (F_{rep} \cdot W_x)/(3D) \quad \ldots\ldots \quad (7)$$

$$V_{stage} = (F_{rep} \cdot W_x \cdot W_y)/(3D) \quad \ldots\ldots \quad (8)$$

11. The apparatus according to claim 1, wherein the deflecting means is a galvanometer.

12. The apparatus according to claim 1, wherein the first controlling means includes a linear motor to move the stage in relation to the to-be-irradiated object in the second direction.

13. The apparatus according to claim 1, wherein the second controlling means includes a pulse motor to move the stage in relation to the to-be-irradiated object in the first direction.

14. The apparatus according to claim 1, wherein the laser source is a solid-state laser.

15. A light irradiating apparatus comprising:

a laser source to emit a light beam;

a moving stage which supports a flat to-be-irradiated object and moves the to-be-irradiated object in a direction parallel with the main surface of the to-be-irradiated object;

an irradiating means including a deflecting means for deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and

which guides the light beam emitted from the laser source and irradiates the light beam to the main surface of the to-be-irradiated object while scanning the light beam in a first direction along the main surface of the to-be-irradiated object; and

a light beam emission controlling means for controlling the light beam emission from the laser source correspondingly to the angle of deflection of the light beam.

16. A light irradiating apparatus comprising:

a laser source to emit a light beam;

a moving stage to support a flat to-be-irradiated object;

an irradiating means including a deflecting means for deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and which guides the light beam emitted from the laser source and irradiates the light beam to the main surface of the to-be-irradiated object while scanning the light beam in a first direction along the main surface of the to-be-irradiated object;

a first controlling means for irradiating the light beam, of which the emission has been controlled by a light beam emission controlling means, to the main surface of the to-be-irradiated object while scanning the light beam in the first direction, and moving the stage in relation to the irradiating means in a second direction perpendicular to the first direction along the main surface of the to-be-irradiated object; and

a second controlling means for controlling the stage, once moved by the first controlling means, to move in relation to the irradiating means in the first direction,

the light beam irradiation controlled by the first controlling means being made to

the same to-be-irradiated surface of the to-be-irradiated object in each of a plurality of different positions along the first direction, reached under the control of the second controlling means, and almost all the to-be-irradiated surfaces of the to-be-irradiated object undergoing the light beam irradiation controlled by the first controlling means in each of the different positions.

17. A light irradiating method comprising:

a light beam emitting step in which a laser source emits a light beam;

an irradiating step including a deflecting step of deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and in which the light beam emitted from the laser source is guided and irradiated the light beam to the main surface of the to-be-irradiated object while the light beam is being scanned in a first direction along the main surface of the to-be-irradiated object;

a light beam emission controlling step of controlling the light beam emission from the laser source correspondingly to the angle of deflection of the light beam;

a first controlling step of irradiating the light beam, of which the emission has been controlled in the light beam emission controlling step, to the main surface of the to-be-irradiated object while scanning the light beam in the first direction, and moving the to-be-irradiated object in relation to the light beam, having been irradiated to the main surface of the to-be-irradiated object in the irradiating step, in a second direction perpendicular to the first direction along the main surface of the to-be-irradiated object; and

a second controlling step of moving the to-be-irradiated object, once moved in the first controlling step, in relation to the light beam irradiated to the main surface in the irradiating step,

the light beam irradiation controlled in the first controlling step being made to the same to-be-irradiated surface of the to-be-irradiated object in each of a plurality of different positions along the first direction, reached in the second controlling step, and almost all the to-be-irradiated surfaces of the to-be-irradiated object undergoing the light beam irradiation controlled in the first controlling step in each of the different positions.

18. The method according to claim 17, wherein in the light beam emitting step, the laser source generates light beam pulses.

19. The method according to claim 18, wherein in the light beam emission controlling step, there are alternately effected a first control mode in which the laser source is controlled to start generation of light beam pulses when the angle of deflection becomes θ_a after taking a first extreme value and to stop generation of light beam pulses when the angle of deflection becomes θ_b after that, and a second control mode in which the laser source is controlled to start generation of light beam pulses when the angle of deflection becomes θ_c after taking a second extreme value and to stop generation of light beam pulses when the angle of deflection becomes θ_d after that.

20. The method according to claim 19, wherein the angles of deflection θ_a and θ_d are

equal to each other and the angles of deflection θ_b and θ_c.

21. The method according to claim 19, wherein the angle of deflection θ_a is a value closer to the first extreme value than the angle of deflection θ_d and the angle of deflection θ_c is a value closer to the second extreme value than the angle of deflection θ_d.

22. The method according to claim 19, wherein the angle of deflection θ_d is a value closer to the first extreme value than the angle of deflection θ_a and the angle of deflection θ_c is a value closer to the second extreme value than the angle of deflection θ_b.

23. A light irradiating method comprising:

a light beam emitting step in which a laser source emits a light beam;

a moving step of moving a flat to-be-irradiated object in a direction parallel with the main surface of the to-be-irradiated object;

an irradiating step including a deflecting step of deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and in which the light beam emitted from the laser source is guided and irradiated to the main surface of the to-be-irradiated object while the light beam is being scanned in a first direction along the main surface of the to-be-irradiated object; and

a light beam emission controlling step of controlling the light beam emission from the laser source correspondingly to the angle of deflection of the light beam.

24. A light irradiating method comprising:

a light beam emitting step in which a laser source emits a light beam;

an irradiating step including a deflecting step of deflecting an incident light beam while changing the angle of deflection periodically in a constant range, and in which the light beam emitted from the laser source is guided and irradiated to the main surface of the to-be-irradiated object while the light beam is being scanned in a first direction along the main surface of the to-be-irradiated object;

a first controlling step of irradiating the light beam controlled in the light beam emission controlling step to the main surface of the to-be-irradiated object while scanning the light beam in the first direction, and moving the to-be-irradiated object in relation to the light beam irradiated to the main surface of the to-be-irradiated object in the irradiating step in a second direction perpendicular to the first direction along the main surface of the to-be-irradiated object; and

a second controlling step of moving the to-be-irradiated object, once moved in the first controlling step, in relation to the light beam irradiated to the main surface of the to-be-irradiated object in the irradiating step,

the light beam irradiation controlled in the first controlling step being made to the same to-be-irradiated surface of the to-be-irradiated object in each of a plurality of different positions along the first direction, reached in the second controlling step, and almost all the to-be-irradiated surfaces of the to-be-irradiated object undergoing the light beam irradiation controlled in the first controlling step in each of the different positions.